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FLORAL COMPOSITION OF RAJASTHAN—A REVIEW*

S. K. JAIN
Botanical Survey of India, Calcutta

ABSTRACT

The paper gives a brief history of botanical exploration in Rajasthan, a synopsis of the floral composition and vegetation, and a fairly comprehensive bibliography.

INTRODUCTION

About 20 years ago Rajasthan attracted the attention of our whole nation, and also of the UNESCO, because some parts of the State are arid, and desertic conditions there had caused some alarm. The aridity and other factors influencing the vegetation were discussed in a symposium organised by the National Institute of Sciences at Delhi in 1952. The problem of aridity was again discussed in a symposium at Jodhpur in 1964.

The State of Rajasthan has been formed by the union of numerous large and small princely states; the latter were interested in study and conservation of the natural resources of their own small areas. The study of the region as a whole did not attract much attention. This is borne by the fact that prior to the publication of Hooker's flora (1872-1897), local floras and lists were available for several regions of India, but almost nothing was written for Rajasthan. Even after Hooker's work, floras, or at least forest floras, were written in the early part of 20th century for practically all parts of India, except Rajasthan. This lacuna was, however, very amply filled during the middle part of the century, particularly the last 20 years. The interest and enthusiasm which the botany departments of various universities in Rajasthan and the Botanical Survey have shown in floristic studies indicate that within next 10 years or so, Rajasthan will be botanically, one of the best explored states in India.

History of botanical exploration: The earliest recorded information on botanical exploration in Rajasthan is about Jacquemont's journey in 1832 from Delhi to Bombay, via Ajmer and Neemuch. Later in 1868, Sir George King made collections in Rajasthan. King's collection were made under curious circumstances (Burkill 1965). About 1866, King was posted as a medical doctor at Calcutta, but he did not keep good health. It was felt that the humid climate of Calcutta did not suit him; and he was posted at drier places like Agra, Mathura, Jodhpur and Mt. Abu. Here, he utilised his leisure in plant collecting. These collections and observations made in 1868 resulted in his paper 'Sketch of the flora of Rajputana' published in 1878; and this, though brief, was the first exclusive account of flora of Rajasthan. One often comes across these collections of King from Marwar, Jodhpur and Mt. Abu, in Calcutta herbarium. Some of these collections were not critically examined after the first annotations by King in 1868, and have sometimes turned out to be interesting new distributional records.

A little later to King, in the years 1869-70, Brandis toured in Rajputana forests and made observations on forest vegetation (1874). Brandis incorporated his observations in his 'Forest Flora of N.W. & C. India' published in 1874. With regard to Rajputana he wrote: "Between the British territory of the Punjab and the N.W. Provinces in the north, and the Central Provinces in the south, intervene the large and important native States of Rajputana, Malwa and Bundelkhand and as the arborescent vegetation of these States is very similar to that of the surrounding British territory, they have been included as far as possible. For these districts my materials are very scanty. It is much to be desired that the results of Dr. George King's botanical explorations of this country may soon be published, and thus supply the deficiencies of this work in that respect."

The work of Brandis, like other forest floras, gives a general distribution of forest species.

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*Based on a paper presented in the symposium on 'Natural Resources of Rajasthan' held at Jodhpur in 1968.

Precise localities of specimens are not cited. The name of the region Rajputana, however, does appear in the distribution of several species.

The next work on the botany of Rajputana was a report of a tour by Duthie (1886). In 1890 Macadam prepared a list of plants of Mt. Abu. Her name has also been guessed as the author of an anonymous work on plants of Jodhpur and Jaisalmer published about same time. For next about 25 years, almost nothing was published on the botany of the region. Between 1918 and 1921, Blatter and Hallberg published a series of papers; herein they enumerated the plants known till then and described several new taxa. For about 30 years, this work remained the only systematic account of plants of Rajasthan. This work however included neither keys to genera and species, nor botanical descriptions of plants. Parker (1918) has mentioned a number of plants from Jaipur.

Ranchandra Rao (1941) and Sankhla (1951) published lists of some plants of the desert region. The studies on the flora of this region were suddenly promoted after the year 1950, and these last 18 or 20 years have been very fruitful. Sarup published lists of plants and account of vegetation of College and University towns, perhaps for places where he or his students were posted as teachers. More than a dozen lists and general papers were published for Jodhpur, Bikaner, Abu, Jaisalmer and Bharatpur (Sarup, 1952, 1954, 1955, 1957, 1958, 1960; Das & Sarup 1951; Sarup & Vyas 1957, 1958; Sarup & Puri 1960). Thereafter several workers contributed to the knowledge of flora of northwestern Rajasthan, such as Biswas & Rolla (1953); Vyas (1955); Ramdeo (1955); Joshi (1956); Ratnam & Ramdeo (1957); Tandon (1958); Jain & Kotwal (1960); Sharma (1962); Rolla & Kanodia (1962); Jain (1963); Bhandari (1964); Bhimaya et al. (1964); Bajpai & Verma (1964); Puri et al. (1964); Verma et al. (1965); Satyanarayan et al. (1966, 1967) and Bhandari 1967). The flora by Puri et al. put together most of the information available upto about 1960. As the voucher specimens for many names included in earlier lists were not available, some misidentifications crept into this work. Now, as more and fresh materials are becoming available, some of these have been resolved. The nomenclature adopted in this flora was then fairly uptodate as compared with earlier works on the region. Some names employed in this flora, which was prepared about 15 years ago, have now changed. Bhandari (1964, 1967) is doing a good job in notifying such name changes as pertain to the plants of Rajasthan.

As regards Mt. Abu, after Macadam's work of 1890, nothing was written till 1940, when Sutaria (1941) and McCann (1942, 1943) wrote short accounts of vegetation. From 1954 to-date several papers have been published on floristics of this hill by Raizada (1954), Chavan & Sabnis (1960), Kanodia & Deshpande (1961), Jain (1962), Ahluwalia (1965), Kanodia and Rolla (1965), Jain (1967) and Gupta and Saxena (1968).

As regards floristics of eastern parts of Rajasthan, one serious bibliographic anamoly has caught my attention. Most of the workers do not mention Duthie's Flora of Upper Gangetic Plains (1903-1922) in their bibliographies. Duthie's Flora is often mistaken for a flora for Uttar Pradesh. In fact U. P. forms only about half of the area, the rest is Rajasthan and Madhya Pradesh. Duthie has occasionally given specific localities like Merwara and even cited Lowrie's and his collections from Rajasthan. He has even mentioned some local Rajputani names of plants. Duthie's work covered major part of southeast and east Rajasthan; none of the workers seem to have kept this jurisdiction of Duthie's work in mind while reporting new records from Udaipur, Kota, etc. Many of these so-called new reports are mentioned by Duthie as common or very common 'in the region of the Flora'. I have dealt with this point only to emphasise that workers on the flora of eastern Rajasthan should consider Duthie's work as a flora already existing for the region. The same applies to the work on grasses by Raizada, Bharadwaja & Jain (1957, 1964, 1966); these also cover eastern Rajasthan.

After Duthie's Flora nothing was written for eastern Rajasthan for about 30 years. Since 1950, a large number of papers has been written on this region and on Aravallis. The full list of these papers will be found in the bibliography. I can refer here only to the work of Mulay and Ratnam (1950), Bakshi (1954), Nair and Nathawat (1956, 1957), Joshi (1957, 1958), Sharma (1958), Nair (1961), Nair et al. (1959, 1961), Jain & Kotwal (1960), Vyas (1962, 1964, 1965), Raizada and Sharma (1962), Gupta (1965) and Vyas & Ramdeo (1965).

Factors affecting the Flora: Before taking up the subject of floral composition of Rajasthan, it would be proper to make a brief mention of some selected literature on the factors affecting the flora and vegetation of this region.

Different ideas have from time to time been put forth regarding origin of the deserts of India, or of other parts of the world. Any interested person could refer to the papers of van Steenis (1934), Stein (1939) and Wadia (1955).

All the various factors responsible for creation or maintenance of desertic conditions, or those directly influencing the flora and vegetation of the region were discussed in the symposium organised by the National Institute of Sciences in 1952. Hora (1952) had dealt with the problems of the Rajputana desert and its value in national economy. Among other papers presented at that symposium, mention could be made of the papers of Krishnan on Geology, Banerji on weather conditions, Vats and Ghosh on Archaeological evidences, Tamhane on Soils, Gokhale & Sarin on Salinity, Ramdas and Paramanik on Hydrology and Pruthi on Insect fauna (all 1962). The Proceedings of this symposium were reviewed by Chapline in 1953.

The climates of dry zone, and the influence of climate on flora and vegetation of dry zones have been given in considerable detail by Waheed Khan (1959); Shanbhag (1958) and Raheja (1965). The soils have been studied by Krishnaswamy & Gupta (1952), Seth (1959), Bharucha (1960), Yadav (1960) and Narayana (1962). Very recently Mondal (1967) reviewed the work on trace elements in Rajasthan soils.

The problem of the Indian and other arid regions has been discussed lately by Mulay and Joshi (1964), Lee (1964) and Mukhopadhyay (1966). The works of Christian (1959) and White (1960) review the prospect of fighting aridity and emphasise that with increasing advancement of science there is every hope that man will be able to immobilize the deserts.

FLORAL COMPOSITION

For assessing the present floral composition of Rajasthan, effort has been made to bring together all the available information, taking the State of Rajasthan as a whole. The total Angiosperm flora of Rajasthan comprises about 1280 species, belonging to about 600 genera and 110 families. For various reasons, these figures cannot be said to be absolutely correct. Some names published in lists may be based on wrong identifications; also opinions differ on some names and status of taxa. It has been mentioned elsewhere that some authors do not clearly indicate whether the plants included by them were found wild, or in cultivation or as escapes. Later authors are obliged to use their own judgement or discretion, which may not always be correct. Also, I do not rule out the possibility of some publication having escaped my notice, but I have tried my best to make the figures reasonably correct and up-to-date.

I have given below some further analysis of these taxa, namely the largest 10 families, largest genera, etc. I have kept Papilionaceae, Caesalpiniaceae and Mimosaceae as separate families; the limits of other families are almost same as adopted by Bentham and Hooker in Genera Plantarum.

The following table gives the number of families, genera and species in Dicotyledons and Monocotyledons:

	DICOTS		MONOCOTS		TOTAL
	No.	%	No.	%	
Families	92	83.7	18	16.3	110
Genera	465	78.4	128	21.6	593
Species	970	75.8	310	24.2	1280

The largest 10 families in the flora are:

According to the number of species :

1. Poaceae: 180 spp. (74 genera)
2. Papilionaceae: 136 spp. (42 genera)
3. Compositae: 86 spp. (51 genera)
4. Cyperaceae: 63 spp. (11 genera)
5. Acanthaceae: 46 spp. (22 genera)
6. Euphorbiaceae: 44 spp. (14 genera)
7. Malvaceae: 40 spp. (11 genera)
8. Labiatae: 35 spp. (13 genera)
9. Convolvulaceae: 35 spp. (11 genera)
10. Scrophulariaceae: 33 spp. (19 genera)

The following 10 families have largest number of genera:

1. Poaceae: 74 genera (180 spp.)
2. Compositae: 51 genera (86 spp.)
3. Papilionaceae: 42 genera (136 spp.)
4. Acanthaceae: 22 genera (46 spp.)
5. Scrophulariaceae: 19 genera (33 spp.)
6. Asclepiadaceae: 16 genera (20 spp.)
7. Euphorbiaceae: 14 genera (44 spp.)
8. Cucurbitaceae: 14 genera (24 spp.)
9. Labiatae: 13 genera (35 spp.)
10. Rubiaceae: 13 genera (19 spp.)

If the Leguminosae is taken as one family, it comprises 51 genera and 177 species. Even then Poaceae remains at the top in both the lists; and the 2nd and 3rd places are retained by Leguminosae and Compositae. Cyperaceae has a high (4th) place in the first list, but none in the second; because the genus *Cyperus* alone contributes about half the number of species of the family; the family has 11 genera.

The following are some of the larger genera in the flora: *Cyperus* (30 spp.), *Indigofera* (20 spp.), *Euphorbia* (18 spp.), *Eragrostis* (15 spp.), *Crotalaria* (15 spp.), *Grewia* (14 spp.), *Ipomoea* (14 spp.), *Cassia* (13 spp.), *Tephrosia* (12 spp.), *Alysicarpus*, *Heliotropium*, *Acacia* all 11 species.

Poaceae, which is the largest family of the region, has only one large genus; large number of smaller genera is responsible for giving it a high place in the list. Four out of the above genera belong to Papilionaceae.

General vegetation and ecology: We can not visualise the flora of a region by merely knowing what families, genera and species occur there; it is necessary to know what plants form the dominant vegetation cover, in trees, shrubs and ground flora. Also the dominant species in different habitat conditions must be known. This brings us to the study of phytosociology, or synecology, or in a broad sense, the vegetation types. Vegetation types of Rajasthan have been described by Champion (1935), Mathur (1960), Puri & Jain (1961), Jain (1963), Champion & Seth (1964), and Mathur & Verma (1964). Ecological accounts of Rajasthan as a whole or smaller regions have been published by Bharucha (1951), Sarup (1952), Agharkar (1952), Biswas (1952), Puri (1952), Joshi (1956,1958), Satyanarayan (1963), Vyas & Ramdeo (1964), Sharma (1962, 1965) and Verma (1967).

The vegetation of western Rajasthan is very different from Aravallis and eastern Rajasthan. Champion (l.c.) had put the entire region of western Rajasthan and also Kutch under his Tropical Thorn Forest. The system of classification of tropical arid lands recently suggested by Pichi-Sermolli (1955) suitably modified, has been found to be fairly satisfactory for western Rajasthan (Jain 1965).

The more common trees in western Rajasthan are: *Acacia* species, *Dichrostachys cinerea*, *Prosopis cineraria*, *Zizyphus* species and in some places *Anogeissus pendula*. Depending on habitat conditions, *Salvadora* spp. and *Tamarix* spp. are also common. The commonest shrubs are *Grewia tenax*, *Euphorbia nivulia*, *Zizyphus* spp., *Capparis* spp. *Maytenus emarginatus*, *Balanites aegyptiaca*, *Commiphora wightii*, *Mimosa hamata*, *Leptadenia pyrotechnica*, *Calligonum polygonoides*, *Calotropis* spp., *Crotalaria burhia*, *Dipterygium glaucum*, *Lycium barbarum*, *Fagonia cretia*, *Bonammia latifolia* and *Sericostoma pauciflorum*. The common grasses are species of *Panicum*, *Cenchrus*, *Lasiurus*, *Cymbopogon*, *Aristida*, etc.

These species form a variety of communities depending on habitat conditions such as rocky areas, sandy areas or saline areas, or dry and exposed areas or moist and protected spots. The best examples of moist and protected spots are the old game reserves or pleasure gardens of Maharajas where almost mixed deciduous vegetation exists even today; *e.g.* at Amarsagar and Badabag near Jaisalmer and Balsamand and Mandor near Jodhpur. The trees *Pongamia*, *Mitragyna*, *Mimusops*, *Terminalia* and *Lagerstroemia* flowering and naturally regenerating in these places remind one of the mixed deciduous forests of Dangs in Gujarat or hilly tracts of Maharashtra.

The other extreme *i.e.* the near-barren sand dunes have few shrublets of xerophytic species of dicotyledons and a few hardy grass species.

The Aravallis and eastern Rajasthan support richer vegetation.

The account given by Mathur (1960) describes the vegetation types in detail. Teak forests are found in Udaipur, Chittorgarh, Baran and Jhalawar Divisions. Other trees associated with teak in these forests are *Anogeissus latifolia*, and species of *Aegle*, *Diospyros*, *Lannea*, *Terminalia* and *Dalbergia*. The undergrowth comprises of species of *Flacourtia*, *Zizyphus*, *Wrightia*, *Helicteres*, *Nyctanthes* and *Holarrhena*. Bamboo clumps occur in moist places. ***Butea*** **is common in lower slopes and plains.**

Anogeissus pendula forests are found in most of the hilly areas on Aravallis and in east Rajasthan. Species of *Acacia*, *Dalbergia*, *Sterculia* and *Albizzia* occur with *A. pendula*. Jain (1965) studied such vegetation at Sawaimadhopur, Ajmer, Dara, Jaipur and Sirohi. *Boswellia* is common on hill tops.

Areas receiving about 800 mm rainfall support mixed deciduous forests, where the chief tree species is *Anogeissus latifolia*. The upper ranges of these hills also have *Boswellia* trees. Good examples of this vegetation type are seen in Udaipur, Kota, Bundi, Sirohi, etc. Jain (1965) studied this type in Udaipur, Shahabad and Sirohi.

Some areas in east Rajasthan also support only the thorn forest as described for west Rajasthan.

The forests at and around Mt Abu are subtropical evergreen forests, comprising trees of *Syzygium*, *Mangifera*, *Erythrina*, *Mallotus*, etc. The undergrowth in these forests is chiefly of *Carvia*, *Caesalpinia*, *Carissa*, etc. Such rich vegetation occurs also in some other restricted spots such as at Sitabari-Kelwara in Shahabad, Ranthanbore at Sawaimadhopur, etc.

I would like to make a special but brief mention of the work on grasses and grasslands and of aquatic vegetation. Limitation of space forbids me from doing it in detail, or from dealing with other plant groups.

Grasslands:

With regard to the study of grasslands, Rajasthan has been fortunate that a person whose name is essentially associated with most of the grassland survey and research in India, was the first to initiate studies on this aspect of vegetation in Rajasthan. I am referring to the work of Shri P. M. Dabadghao, who published his earliest work on grasslands of arid and semiarid regions of India about 15 years ago (*Dabadghao* 1957). Since then, he and his associates have prepared several accounts of grasslands, ecology of grasses and grazing problems (*Dabadghao,* 1957a, b, 1958, 1960; *Dabadghao et al.* 1963; *Das et al.* 1963, 1964). Officers of the Grassland Survey Scheme of Indian Council of Agricultural Research and many forest officers have published papers on grasslands of this region (*Nanda* and *Khera* 1959, *Prakash* and *Nanda* 1961, *Aggrawal* 1961, *Prakash* and *Ahuja* 1964). With the establishment of the Central Arid Zone Research Institute, the study of grasslands too received more attention and the Ecologist, Agrostologist and Plant Physiologist of the Institute have published works on Ecology, Physiology, germination etc. of grasses e.g. the work of Lahiri and Kharbanda (1961, 1963), Chakrabarty (1964), Shankarnarayan and Satyanarayan (1964) and Gupta and Saxena (1966).

As regards taxonomy of grasses, one must take note of the monumental work of Dr. N. L. Bor (1960), wherein he has brought together a very vast and scattered literature and information on taxonomy and phytogeography of Indian grasses. There is no separate account of grasses of Rajasthan. Papers describing or enumerating grasses of smaller areas such as of Jaipur by Gandhi *et al.* (1961), of Mt. Abu by Kanodia and Rolla (1965, 1966), of Pilani by Ramachandran (1950) and of Jhunjhunu by Joshi and Sarma (1967) have contributed much to better understanding of grass flora. The area covered by the work 'Grasses of Upper Gangetic Plains' by Raizada, Jain and Bharadwaja (1957, 1964, 1966) includes greater part of eastern Rajasthan. Diagnostic keys to genera and species and illustrations given in this work should help in identification of almost all grasses of Rajasthan. The series of papers on taxonomy of grasses by Jain (1966a, b, 1968) refer to many new records etc. from Rajasthan. The establishment of a special Institute at Jhansi for the study of grasses and grasslands of India gives us the hope that this important but neglected subject will now receive adequate attention.

Aquatic Vegetation: References to aquatic vegetation or plants have been made in most of the floristic accounts mentioned earlier. Some authors have, however, studied and described hydrophytes in particular. Mention can be made of the papers of Ratnam and Joshi (1952), Sarup (1958a, b, 1960), Mehra (1960), Vyas (1964) and Gupta (1966) on hydrophytes and marsh plants of Pilani, Jodhpur, Bharatpur, Nandwara, Alwar and Kota. These papers are either a general account of aquatic vegetation or mere lists of plants. It can be hoped that a closer study of the hydrophytes of Rajasthan should also yield novelties. I have covered in this review only the higher plants. Not that the study of other groups of plants is less important; my personal limitations alone are responsible for this partiality. The work of Gupta (1962) on the genus *Marsilea* is known far outside the boundaries of our country. The ferns of Mt. Abu have been studied by Bir (1961) and the Hepatic flora by Bapna (1958).

Phytogeographic considerations: Phytogeographycally, the western and northwestern Rajasthan has always been regarded as almost a distinct unit in Indian vegetation. Clarke (1898) called this region as 'Indian Deserta'. Hooker (1907) and Chatterji (1935) called it as the 'Indus Plain'. The flora has resemblance with arid regions of Pakistan and even of Arabia and Africa.

The flora of Aravallis and eastern Rajasthan is dissimilar from western Rajasthan. This point was brought out as early as 1878 by King and has been elaborated by many later workers (*Champion* 1936, *Puri et al.* 1964, *Jain* 1965 and *Vyas* 1964).

The flora of Mt. Abu is of particular phytogeographic significance. Jain (1967) has shown that this hill has served as a meeting ground for the north Indian and peninsular elements of flora in India. Mt. Abu is the northernmost limit for certain plants of peninsular region, and the southernmost limit for certain Himalayan or north Indian plants. Also Mt. Abu has contributed to the endemic elements of Rajasthan flora.

Endemism: The only notable work on endemism in India was by Chatterji (1939), 30 years ago.

Rajasthan lies in the zone of poor endemism, and as far as we know even today the flora does not show high endemism. There are two main reasons for this. Firstly the area is not 'isolated', i.e. the conditions of environment and soil are such as occur widely in the neighbouring regions such as Haryana, western Uttar Pradesh, Gujrat and western Madhya Pradesh; they are not exclusive to the region. Mt. Abu, which due to its altitude is to some extent isolated from the surrounding territory, does have some endemic taxa, e.g., some of the taxa described by Blatter (1930). Secondly, the flora is still incompletely known. Intensive exploration and monographic studies must reveal new endemic taxa. Endemism in Rajasthan could in fact be studied at two levels: plants endemic to Rajasthan State alone, and plants occurring in Rajasthan, endemic to the country. No work has been published on endemism in Rajasthan alone. Some taxa described by Blattei & Hallberg (1918-1921) and by Blatter & McCann (1926-1935) have not still been reported from elsewhere, and can be considered to be endemic e.g., *Cleome gynandra* var. *nana* (Bl. & Hall.) Bhandari, *Convolvulus blatteri* Bhandari, *Farsetia macrantha* Bl. & Hall., *Cleome brachycarpa* Vahl ex DC. var. *glauca* Bl. & Hall., *Abutilon fruticosum* Guill. Perry et A. Rich. var. *chrysocarpa* Bl. & Hall., *A. indicum* Sw. var. *major* Bl. & Hall., *Pavonia arabica* Steud. var. *glutinosa* Bl. & Hall., *Methania magnifolia* Bl. & Hall., *Zizyphus truncata* Bl. & Hall., *Psoralia odorata* Bl. & Hall., *Tephrosia uniflora* subsp. *petrosa* (Bl. & Hall.) Gillett & Ali.

The same applies to the various taxa described recently from Rajasthan e.g. *Lasiurus caudatus* and *Cenchrus rajasthanensis*. As regards the second aspect, out of 134 dicot genera listed by Chatterji (l.c.) as endemic to India, only six, namely *Ougeinia, Butea, Caesulia, Glossocardia, Petalidium* and *Haplanthus* are reported to occur in Rajasthan.

Economic aspects: The study and knowledge of flora cannot remain merely an academic field. Plants are an important natural resource of a region. Forestry, agriculture and other minor plant-based industries are intimately related here. But it is often impossible to draw a line between floral composition, forest wealth or medicinal resources. I have therefore included some more important papers on these subjects in the bibliography. I would recall here that it was in 1869 and 1870 when King wrote two papers on famine foods of Rajasthan. I have come across in literature one still earlier reference 'Some account of the general medical topography of Ajmer' published in 1843 by Irvine but I have not been able to have a look at this work.

The question of afforestation, agriculture, farm-forestry and grassland management are now-a-days considered very interdependent and they are studied from the view point of overall land utilisation or land use. Bhimaya, Kaul, Mahendra Prakash, Raheja, Seth, Waheed Khan and their associates have written numerous papers on afforestation, desert immobilisation, land use, etc. Some of these papers are included in the bibliography.

Having reviewed the history of botanical exploration in Rajasthan and the present state of our knowledge of the floral composition, phytogeography, endemism and economic aspects of the flora, I would make a mention of the prospects of future floristic studies in this State.

Prospects of future floristic studies: There is now practically no region in Rajasthan which we could call 'virgin' in true sense; yet publications on some areas are very sketchy or mere short abstracts and such areas could be called as almost unexplored. Also, though certain places like Jodhpur, Pilani, Abu and Alwar have been fairly well explored recently, until detailed floras for these are published, we could not label them as fully explored. I have put three categories on the basis of explorations and publications.

The districts on which 5 or more than five papers have been published have been regarded as fairly well explored. Districts on which only 3 or 4 papers have been published, have been considered as underexplored. The districts on which only one or two papers, or only abortive papers have been published are considered as almost unexplored. Apart from the number of papers, the size, contents or substance and how recent the work is, has also been taken into account. This categorisation cannot, of course, be very accurate; it is merely for the guidance of new research workers.

1. Fairly well-explored: Sirohi (including Mt. Abu), Jodhpur, Jhunjhunu (including Pilani) and Alwar.
2. Under-explored: Udaipur, Sikar, Churu, Ajmer, Jaipur, Barmer, Jaisalmer, Bikaner.
3. Almost unexplored: The remaining areas.

A stage has certainly been reached now, when, firstly a check-list for Rajasthan should be published; and secondly, monographic work should be taken up on genera and smaller families.

The *Check-list* which should include important

Synonymy and cross references, will help in two ways. It shall enable workers to filter their suspected new records from Rajasthan and it will bring about consistency in nomenclature in future publications.

Some research students in Rajasthan should take up monographic works on small families or genera pertaining to Rajasthan. This is necessary for removing confusions in the identity and nomenclature of plants. Voucher specimens for names published in the lists are sometimes not available. Writers of floristic accounts have often to accept these names on the authority of the authors of those papers. Authors of large floras can not always be so critical as to verify the identity, taxonomic status and above all the nomenclature of the several hundreds (or thousands) species occurring in the area.

Detailed and critical accounts of some genera and families have already been published; these have resolved some very old misidentifications, nomenclatural errors, etc. Mention can be made here of the work of Nair & Kotschy (1963), on *Indigofera,* Chatterjee and Bharadwaja (1953) on Scrophulariaceae, Kanodia (1968) on *Aristida,* Raizada and Jain (1957, 1964, 1966) on Poaceae, Chavan, Sabnis (1960) and Vyas (1966) on Cyperaceae, Bhandari (1954) on *Ephedra,* etc.

· Taxonomic monographs dealing with whole of India are too many to be enumerated here or even in bibliography. I have mentioned towards end of this paper references of some bibliographic works on taxonomy for the benefit of interested persons.

Small dissertations on such problems could be worked out for M. Sc. and Ph. D. theses.

It has often been suggested that our research activities should have a bearing on economic problems. Taxonomic research may not seem to have much practical application; it certainly is a meaningful science. In order to make monographic studies really useful and meaningful, it will be good to give priority to genera which are economically more important or more common. With particular reference to Rajasthan, I could suggest the following kinds of taxa for the monographic work:

1. Genera of fodder grasses as *Bothriochloa, Dichanthium, Chrysopogon, Sporobolus, Aristida* and *Panicum.*
2. Genera of importance in forestry:—*Acacia, Anogeissus, Diospyros, Capparis, Zizyphus, Euphorbia, Ficus.*
3. Genera of other economic importance e.g., *Hibiscus, Sida, Abutilon, Crotalaria, Grewia, Corchorus, Cassia, Jasminum, Ipomoea, Solanum, Cyperus,* etc.

Publications and their availability: I would like to mention something regarding publications of research findings. Some early works on flora of Rajasthan, such as papers of Macadam and Irvine are not easily available. Copies of these publications will be lying in some libraries where they will never be consulted, *e.g.*, in the Darbar libraries of some old Maharajas, or in the libraries under the control of revenue authorities. The greater pity however is that even some of the more recent publications i.e. of the years 1940 onwards are not easily accessible. Many papers have been published just as pamphlets or booklets, some in obscure journals, or even in University magazines,—magazines!, not research journals.

Publication of research papers in University journals is alright if the journal is distributed to most of the University and research libraries of the country. It is safer to confine irregular periodicals to popular or semitechnical articles. Research findings, which are likely to be used by wider circle of people must find place in known journals, or at least the authors should make efforts to get such papers abstracted in known abstracting journals, such as Biological Abstracts, Indian Science Abstracts, etc.

Many superfluous new distributional records, new combinations and even superfluous new names will thus be excluded.

It is fortunate that the quality of research papers on floristics of this region has in general been consistently improving. More and more authors are following the requirements of Code of Nomenclature. Almost all authors are now quoting voucher specimens for their enumeration lists.

In a floristic account, the status of an indigenous and an exotic plant is very different. It must always be mentioned by the authors whether they collected the specimen in wild state or in cultivation, or if they suspect the plant to be an escape. For a number of species reported from Rajasthan, this position is not quite clear.

The bibliography appended with the paper includes all references cited in the text and also other papers useful in the study of flora of Rajasthan. Floras and taxonomic monographs pertaining to other regions of India are valuable aids in the study, but it is not practicable to include them all here. Interested reader may refer to the bibliographies by

Blatter (1911), Agharkar (1938), Biswas (1943), Santapau (1952, 1953, 1958), Majumdar (1957), Narayanswami (1961, 1965), Jain (1961), Gupta (1966); and review works on Nomenclature by Raizada (1958, 1966, 1968) and Jain (1967).

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REFERENCES

Agarwal, S. K., R. K. Garg and M. P. Singh Ranawat. Two new plant records for Rajasthan. *Sci. & Cult.* 37 : 33-34, 1971.

Aggarwal, S. C. Grassland communities of dry tropical forests. *Indian For.* 87(5) : 309-315, 1961.

Agharkar, S. P. Progress of botany during the past 25 years (1910-1935). In B. Prasad's *Progress of Science in India,* 1938.

—— Plant ecology of the Rajputana desert. *Bull. nation. Inst. Sci.* 1 : 246-247, 1952.

Ahluwalia, K. S. Contribution to the flora of Mt. Abu. *Indian For.* 91 : 824-828, 1965.

Badhwar, R. L., A. C. Dey and A. L. Griffith. The afforestation of dry and arid areas. *Indian For. Bull.* 133, 1947.

Bajpai, M. R. and J. K. Verma. Weed flora of Jobner. *Annals Arid Zone.* 2 : 169-180, 1964.

Bakshi, T. S. Vegetation of Pilani and its neighbourhood. *J. Bombay nat. Hist. Soc.* 52 : 484-514, 1954.

Banerji, J. Role of vegetation in desert control. *Bull. nation. Inst. Sci.* 1 : 277-283, 1952.

Banerji, S. K. Weather factors in creation and maintenance of the Rajputana desert. *Ibid.* 1 : 153-166, 1952.

Bapna, K. P. A note on the Hepatic flora of Mt. Abu. *Curr. Sci.* 27 : 259-260, 1958.

Basu, J. K. Soil conservation, vital need of the nation. *Proc. Indian Sci. Cong.* II : 227-253, 1951.

Bhadran, C. A. R. Principles of reforestation of degraded areas and rehabilitation planting. *Indian For.* 83 : 409-415, 1957.

Bhandari, M. M. On the occurrence of *Ephedra* in the Indian desert. *J. Bombay nat. Hist. Soc.* 52 : 10-13, 1954.

—— Plant abnormalities from the Indian desert. *Proc. Indian Sci. Cong.* III: 307, 1962.

—— New plant records for northwest Indian desert. *Ibid.* 307-308, 1962.

—— Notes on Indian desert plants. I. New records for northwest Indian deserts. *Proc. Rajasthan Acad. Sci.* 10: 40-50, 1963.

—— Notes on Indian desert plants. II. On the identity and nomenclature of *Talinum portulacifolius* (Forsk.) Asch. & Sch. *Annals Arid Zone.* 1 : 176-179, 1963.

—— Notes on Indian desert plants. III. Critical notes on some recently reported new records. *Ibid.* 2 : 181-184, 1964.

—— Notes on Indian desert plants. IV. New names and combinations. *Bull. bot. Surv. India.* 6 : 327-328, 1964.

—— On *Coccinia grandis* (L.) Voigt. *Annals Arid Zone.* 4 : 227-229. 1965.

—— Flora of the Indian desert. VI. Additions, corrections and some nomenclatural notes. *Ibid.* 6 : 200-210, 1967.

—— & D. Singh. *Dactyliandra* (Hook. f.) Hook. f., a Cucurbitaceous genus new to Indian flora. *Kew Bull.* 19: 133-138, 1964.

Bharadwaj, O. P. The arid zone of India and Pakistan. In 'A' History of Landuse in Arid Regions' Unesco, XVII, 143-173, 1961.

Bharucha, F. R. The ecological problems of the Rajasthan desert. VIII Silv. Conference, Dehra Dun. 1951.

—— The structure and physiological features of the Rajasthan desert. *Arid Zone Res. Ser. V.* (Pl. Ecol.) 34-36, 1955.

—— Afghanistan, India and Pakistan. *Ibid.* VI. 19-39, 1955.

—— Ecological studies of the Rajasthan desert soils. *Proc. nation. Inst. Sci.* 26B : 233-256, 1960.

Bhatnagar, M. P., P. D. Bhargawa and K. Kumar. Survey of Oil-seed crops in Rajasthan. I. Rapeseed & mustard. *Indian Oil. J.* 4 : 251-257, 1960.

Bhimaya, C. P., A. B. Bose and S. P. Malhotra. The human factor in relation to trees & shrubs in a village in arid parts of Rajasthan. *Indian For.* 87: 614, 1961.

——, A. Cherian and Y. Satyanarayana. Preliminary studies on the vegetation of Kailana. *Ibid.* 90 : 667-675, 1964.

—— and M. D. Chowdhary. Plantations of wind-breaks in the Central Mechanised Farms, Suratgarh. *Ibid.* 87 : 354-367, 1961.

—— and R. N. Kaul. Some afforestation problems & research needs in relation to erosion control in arid & semi arid parts of Rajasthan. *Ibid.* 86 : 453-468, 1960.

——, —— and B. N. Ganguli. Sand dune rehabilitation in Western Rajasthan. *Sci. & Cult.* 27 : 224-229, 1961.

——, ——, —— and P. N. Bhatt. Experimental afforestation of rocky refractory sites in the arid zone. *Indian For.* 90 : 160-163, 1964.

——, ——, ——, I. S. Tiagi, M. D. Chowdhary and R. Subbayya. Species suitable for afforestation of different arid habitats of Rajasthan. *Annals Arid Zone.* 2 : 162-168, 1964.

——, D. K. Misra and R. B. Das. Importance of shelter-belts in arid zone farming. *Proc. Farm-forestry Symp.* ICAR. 1958.

Bir, S. S. and S. C. Verma. Ferns of Mt. Abu. *Proc. Indian Sci. Cong.* III. 270-271, 1961.

Biswas, K. Systematic & taxonomic studies on the flora of India and Burma. *Ibid.* II. 101-152, 1943.

—— Desert vegetation. *Bull. nation. Inst. Sci.* 1 : 247, 1952.

—— and Rolla, S. R. Rajputana desert vegetation *Proc. nation. Inst. Sci.* 19 : 411-421, 1953.

Blatter, E. A bibliography of the botany of British India and Ceylon. *J. Bombay nat. Hist. Soc.* 20: 79-185, 1911.

—— New species of Indian plants. *J. As. Soc. Bengal* (n.s.) 26:339-366, 1930.

—— and F. Hallberg. The flora of the Indian desert (Jodhpur and Jaisalmer). *J. Bombay nat. Hist. Soc.* 26 : 218-246, 525-551, 811-818, 962-967; 27 : 40-47; 270-279 and 506-519, 1918-1921.

—— and C. McCann. Revision of the flora of Bombay Presidency. *Ibid.* from 1926 to 1935 in 27 parts. 1926.

——, —— and T. S. Sabnis. The flora of the Indus delta. *J. Indian bot. Soc.* vols. 6, 7, 8 from 1927 to 1929 in7 parts. 1927.

Bor, N. L. *The Grasses of Burma, Ceylon, India & Pakistan.* London. 1960.

Brandis, D. *The Forest Flora of Northwest & Central India.* London. 1874.

Burkill, I. H. *Chapters on History of Botany in India.* Calcutta. 1965.

Calder, C. C., V. Narayanswami and M. S. Ramaswami. List of species & genera of Indian Phanerogams not included in Flora of British India. *Rec. bot. Surv. India* 11 : 1-157, 1926.

Champion, H. G. A preliminary survey of forest types of India & Burma. *Indian For. Rec.* (Silv.) N. S. 1 : 1-286, 1936.

Champion, H. G. and S. K. Seth. *A revised survey of Forest types of India*, 1964.

Chapline, W. R. The Rajputana desert. *Curr. Sci.* 22 : 161-164, 1953.

Chatterjee, D. Studies on the endemic flora of India & Burma. *J. Roy. Asiatic Soc. Bengal.* II. 5 : 19-67, 1939.

—— and R. C. Bharadwaja. Revision of the Scrophulariaceae of Upper Gangetic Plains & adjoining areas. *Bull. bot. Soc. Bengal* 9 : 127-153, 1955.

Chaturvedi, M. D. The Rajputana desert, a scheme for its immobilization. *Bull. nation. Inst. Sci.* 1 : 269-272, 1952.

Chavan, A. R. and S. D. Sabnis. Cyperaceae from Mt. Abu. *J. Indian bot. Soc.* 29 : 27-29, 1960.

Chopra, I. C. and B. K. Abrol. Some medicinal plants suitable for cultivation in Indian arid zone. *Symp. Probl. Indian Arid Zones.* 148-153, 1964.

——, —— and K. L. Handa. Medicinal plants of the arid zones. I. *Arid Zone Res. Ser.* XIII. 11-53, 1960.

Christian, C. S. An arid zone research institute for India. *Arid Zone* 5 : 6-9, 1959.

Clarke, C. B. On the sub-areas of British India. *J. Linn. Soc.* (Bot.) 34 : 1-146, 1898.

Dabadghao, P. M. Ecology of grasslands in arid & semiarid tracts of India & the principles of their management. *Unesco symp. on 'Soil erosion & its control in arid & semiarid zones'.* 133-139, 1957.

—— Grasslands and grassland problems in West Rajasthan *Proc. II Seminar Soil Conservation.* 139-145, 1958.

Das, R. B. and C. P. Bhimayya. Pasture ecology of grasslands of West Rajasthan. *Proc. Symp. Prob. Indian Arid Zones.* Jodhpur. 399-412, 1964.

—— and S. Sarup. The biological spectrum of the Indian desert. *Univ. Rajasthan Stud.* (Biol. Sc. Sect.) 1 : 36-42, 1951.

Dhir, R. D. Hydrological research in arid & semiarid regions of India & Pakistan. *Arid Zone Res. Ser.* 1 : 96-127, 1953.

Duthie, J. F. *A botanical tour in Merwara (Raj.), a report*, Calcutta, 1886.

——*Flora of the Upper Gangetic Plains*, Calcutta. 1903-1922.

Gandhi, H. P. A contribution to our knowledge of fresh water diatoms of Pratabgarh (Raj.) *J. Indian bot. Soc.* 34 : 307-338, 1955.

Gandhi, S. M., P. D. Bhargawa and M. P. Bhatnagar. Grasses of Jaipur. *Proc. nation. Acad. Sci.* 31B : 183-192, 1961.

Ghosh, A. The Rajputana desert, its archeological aspect. *Bull. nation. Inst. Sci.* 1 : 37-42, 1952.

Griffith, A. L. The vegetation of Thar desert of Sind. *Indian For.* 72 : 307-309, 1946.

Gupta, K. M. *Marsilea. Botanical Monograph No. 2, CSIR*, New Delhi, 1962.

Gupta, R. K. Bibliography on the ecology (synecology & phytosociology) of arid & semiarid regions of India. *Exc. Bot.* 7: (B) 178-190, 1966.

——and S. K. Saxena. Habitat, grassland types & forage potential of Jalore dist. in West Rajasthan. *Annals Arid Zone* 5 : 189-203, 1966.

——and——Some ecological observations on the vegetation of Mt. Abu in West Rajasthan. *Indian For.* 94 : 315-333, 1968.

Gupta, R. S. A conrtibution to flora of Rajasthan. *Ibid.* 91 : 438-439, 1965.

——Vegetation of Kota & its neighbourhood. *Trop. Ecol.* 6 : 63-71, 1965.

——Occurrence of *Cuscuta reflexa* R. in Alwar. *Indian For.* 92 : 406-409, 1966.

——A study of Hydrophytes and marsh plants of Kota & environs (India). *Trop. Ecol.* 7 : 153-162, 1966.

Hingorani, G. R. and R. C. Gaur. Short note on occurrence of *Heliotropium curassavicum* L. in Rajasthan. *Indian For.* 91 : 293, 1965.

Hooker, J. D. *The Flora of British India.* London, 1872-1897.

——*Botany, in Imperial Gazetteer of India*, ed. 3. 1 : 157-212, 1907.

Hora, S. L. The Rajputana desert, its value in national economy. *Bull. nation. Inst. Sci.* 1 : 1-11, 1952.

Irvine, R. H. *Some account of medical topography of Ajmer*, 1843.

Jain, S. K. *Index to Duthie's Flora of Upper Gangetic Plains.* CSIR. Delhi, 1952.

——Observations on vegetation of Sawaimadhopur in Rajasthan. *Bull. intern. Soc. Trop. Ecol.* 1 : 29, 1960.

——The genus *Dipterygium* Decne in India. *Bull. bot. Surv. India* 2 : 171, 1960.

——A contribution to bibliography of Gramineae. *Proc. nation. Acad. Sci.* 31B : 361-382, 1961.

——Materials for flora of Mt. Abu in Rajasthan. *Indian For.* 88: 53-63, 1962.

——Invasion of plants in arid regions of India. *Proc. nation. Acad. Sci.* 33 B : 58-60, 1963.

——*The vegetation of arid, semi-arid and some adjacent regions of Western India.* Ph. D. thesis, Poona University, 1965.

——Notes on Indian grasses. I. Distribution of the less known species of *Cynodon. Indian For.* 92 : 201-202, 1966.

——Notes on Indian grasses. II. *Ibid.* 92 : 362-367, 1966.

——*Vanaspati Kosh.* A Hindi Latin Dictionary of economic plants. Rajkamal, Delhi, 1967.

——Phytogeographic considerations on the flora of Mt. Abu. *Bull. bot. Surv. India* 9 : 68-78, 1967.

——Notes on Indian grasses. IX *Proc. Indian Sci. Cong.* III. 426-427, 1968.

——and D. K. Banerjee. Notes on Indian Grasses VI. *Sci. & Cult.* 33 : 117-119, 1967.

——and N. N. Kotwal. Vegetation of Shahabad in Rajasthan. *Indian For.* 86 : 602-608, 1960.

——and——A note on some little known plants from Rajasthan. *Sci. & Cult.* 26 : 191-192, 1960.

Jain, T. C. and D. K. Misra. Two new varieties of *Ricinus communis* L. from Arid Zone. *Annals Arid Zone* 4 : 43-45, 1965.

Joshi, M. C. Plant ecology of Bikaner & its adjacent area in comparison with rest of western Rajasthan. *J. Indian bot. Soc.* 35 : 495-511, 1956.

——A comparative study of vegetation of some areas in Jaipur division. *Ibid.* 36 : 272-291, 1957.

——A preliminary survey of sand dune vegetation of Pilani and its neighbourhood. *Ibid.* 37 : 309-327, 1958.

——*An Ecological survey of vegetation in sand dune region round about Pilani, Rajasthan.* Ph. D. thesis. Rajasthan University, 1958.

——and C. B. S. R. Sarma. Study of grasses & sedges of certain areas in Jhunjhunu district (Rajasthan). *Proc. Symp. Prob. Ind. Arid Zone*, Jodhpur, 394-398, 1964.

——and——Grasses of certain areas in Jhunjhunu dist., Rajasthan. *Indian For.* 92 : 570-575, 1966.

Joshi N. C. Fungi of Ajmer (Rajasthan). *Indian J. mycol. Res.* 2 : 65-70, 1958.

Kanitkar, N. V. Rajputana desert & its reclamation by dry farming methods. *Bull. nation. Inst. Sci.* 1 : 260-265, 1952.

Kanodia, K. C. An account of vegetation of Banswara dist. *Proc. Indian Sci. Cong.* I : 428-429, 1963.

——*Rumex crispus* L., a member of Polygonaceae new to Indian flora. *Bull. bot. Surv. India* 5 : 377-379, 1963.

——Contribution to vegetation of Udaipur dist. *Proc. Indian Sci. Cong.* III: 401, 1965.

—— and U. R. Deshpande. Additions to flora of Mt. Abu. *Bull. bot. Surv. India* 3 : 403-405, 1961.

—— and P. C. Nanda. The genus *Aristida* in Western Rajasthan. *Indian For.* 94 : 296-302, 1968.

Kanodia, K. C. and Rolla, S. R. Grasses of Mt. Abu, Rajasthan State. *Annals Arid Zone* 4 : 110-119 and 5 : 49-62, 1965.

Kaul, O. N. Roadsides planting in arid wastes of Rajasthan. *Indian For.* 82 : 457-461, 1957.

Kaul, R. N. An outline of problems of arid zone forestry & research approach. *Proc. II. Sem. Soil Conser. Ootacamund.* 131-133, 1958.

—— Shelter-belts to stop creep of the desert. *Indian For.* 85 : 191-195, 1959.

—— An approach to provenance trials in relation to tree introduction in arid lands. *Annals Arid Zone* 4 : 164-171, 1965.

—— and B. N. Ganguli. Plant introduction in the arid zones of India. *Proc. nation. Acad. Sci.* 33 B : 67-88, 1963.

King, G. Notes on famine foods of Marwar. *Proc. Asiat. Soc. Bengal* 116-121, 1869.

—— Notes on vegetable products used as food during late famine in Rajputana. *Trans. bot. Soc. Edinb.* 10 : 198, 1870.

——Sketch of the Flora of Rajputana, Calcutta. (Repr.) *Indian For.* 4 : 226-236, (1878) 1879.

Krishnan, M. S. Geological history of Rajasthan and its relation to present dry conditions. *Bull. nation. Inst. Sci.* 1 : 19-31, 1952.

Krishnaswamy, V. S. and R. S. Gupta. Rajputana desert, its vegetation and its soil. *Indian For.* 78 : 595-601, 1952.

Lee, Douglas H. K. The sands of time-Man's struggle against aridity. *Annals Arid Zone* 3 : 25-32, 1964.

Macadam, Miss. *A list of trees & plants of Mt. Abu.* 1-28. Jodhpur. 1890.

Macadam, Miss(?) *Introductory note to Jodhpur & Jaisalmer trees & plants.* 1890(?)

Mahabale, T. S. and A. Kharadi. On some ecological features of the vegetation of Mt. Abu. *Proc. nation. Acad. Sci.* 16 B. 13-23, 1946.

Majumdar, G. P. *Progress of Science in India.* 6. Botany. (1939-1950) 1957.

Mathauda, G. S. Grazing problem & control of Rajasthan desert. *Indian For.* 83 : 603-605, 1957.

——Impressions of a tour in Rajasthan. *Ibid.* 84 : 418-423, 1958.

Mathur, C. M. Forest types in Rajasthan. *Ibid.* 86 : 734-739, 1960.

——and S. K. Verma. Vegetation types of Sirohi Division. *Ibid.* 90 : 413-430, 1964.

McCann, C. A busman's holiday in the Abu hills. *J. Bombay nat. Hist. Soc.* 43 : 206-217, 1942.

——The rains came to the Abu hills. *Ibid.* 43:641-647, 1943.

Meher-Homji, V. M. A contribution to the study of plant succession & climax vegetation with special reference to dry parts of northwest and southeast India. *Trop. Ecol.* 6 : 152-164, 1965.

Mehra, R. K. A survey of aquatic weeds of Nandanwara reservoir with suggestions for their control. *Proc. Indian Sci. Cong.* III. 415-416, 1960.

Misra, D. K. Agronomic investigations in arid zone. *Proc. symp.* Jodhpur, 313-324, 1964.

Mondal, R. C. Review of work on trace elements in Rajasthan. *Annals Arid Zone* 6 : 161-170. 1967.

Mukhopadhyay, S. Man's will to win over deserts.—India on the move. *Sci. & Cult.* 32 : 436-440, 1966.

Mulay, B. N. and M. C. Joshi. A study in the problems of Rajasthan deserts. *Proc. symp. Prob. Indian Arid Zone,* Jodhpur. 125-134, 1964.

——and S. C. Mathur. Preliminary ecological survey of plant communities in & around Tonk Dist. (Rajasthan). *Proc. Rajasthan Acad. Sci.* 8 : 31-42, 1961.

——and B. V. Ratnam. Study of vegetation found round about Pilani & its neighbourhood. *Proc. Indian Sci. Cong.* III. 64-65, 1950.

Nair, N. C. A study of vegetation & choice of species in the afforestation of Rajasthan. *Proc. nation. Acad. Sci.* 24 B:164-176, 1954.

——Flora of Chirawa. *Proc. Rajasthan Acad. Sci.* 6 : 49-64, 1956.

——Vegetation of Jhunjhunu, Mandrela & the neighbouring places. *J. Bombay nat. Hist. Soc.* 58 : 433-440, 1961.

——and R. K. Bhartya. A note on *Euryale ferox* Salisb. in Alwar, Rajasthan. *Ibid.* 59 : 323, 1962.

——and M. B. Deshpande. Note on occurrence of *Acanthospermum hispidum* DC. in Rajasthan. *Ibid.* 57 : 441-442, 1960.

——and M. C. Joshi. Sand-dune vegetation of Pilani & its neighbourhood. *J. Indian bot. Soc.* 36: 599-617, 1957.

——and K. C. Kanodia. A study of vegetation of Ajitsagar Bundh. *J. Bombay nat. Hist. Soc.* 56 : 524-557, 1959.

——, ——and T. A. Thomas. Vegetation of Khetri town & its neighbourhood. *Proc. Rajasthan Acad. Sci.* 8 : 99-110, 1961.

——and T. T. Koshy. A taxonomic study of the genus *Indigofera* L. in Rajasthan. *J. Bombay nat. Hist. Soc.* 60 : 326-336, 1963.

——and S. K. Malhotra. A study of the vegetation of Lohargal and its neighbourhood. *Bull. bot. Surv. India* 3 : 139-151, 1961.

——and G. S. Nathawat. Vegetation of Pilani & its neighbourhood. *J. Bombay nat. Hist. Soc.* 54 : 91-106, 1956.

——and——Vegetation of Harshnath, Aravalli hills. *Ibid.* 54: 281-301, 1957.

——and T. A. Thomas. Three new plant records in Rajasthan. *Curr. Sci.* 31 : 26, 1962.

Narayanaswami, V. *A bibliography of Indology* Vol. 2. *Indian Botany.* Pt. I. A-J and Pt. II. K-Z (1965), 1961.

Nathawat, G. S. and B. D. Deshpande. Plants of economic importance from Rajasthan I: *Acacias. Proc. Rajasthan Acad. Sci.* 7 : 38-47, 1960.

Parker, R. N. *A Forest Flora for the Punjab with Hazara and Delhi.* Lahore, 1918.

Prakash, I. Destruction of vegetation by animals in Rajasthan. *Indian For.* 85 : 251-253, 1959.

Prakash, M. and L .D. Ahuja. Studies on different range condition class grasslands in west Rajasthan. *Annals Arid Zone.* 3 : 91-98, 1964.

——and P. C. Nanda. Ecological distribution of natural fodder grasses in western Rajasthan. *Indian For.* 87 : 10-19, 1961.

——and S. Pathak. Brick-planting in shifting sands of Rajasthan. *Ibid.* 83 : 224-225, 1957.

Puri, G. S. Present position of plant ecology of the deserts of Rajasthan & Saurashtra. *Bull. nation. Inst. Sci.* 1 : 233-240, 1952.

——and S. K. Jain. Trees or grasslands in Rajasthan. *Indian For.* 86 : 85-86, 1960.

——and——Succession of plant communities in the Rajasthan Aravallis. *Ibid.* 87 : 745-750. 1961.

——and——Botanical exploration in Western India. *Trop. Ecol.* 3 : 49-69, 1962.

——, ——, S. K. Mukerjee, N. N. Kotwal and S. Sarup. Flora of Rajasthan. *Rec. bot. Surv. India* 19 : 1-159, 1964.

Raheja, P. C. Research & Development in Indian arid zone. *Unesco News Letter* No. 15 : 7, 1962.

—— Shelter belts in arid climates & special techniques for tree planting. *Annals Arid Zone* 2 : 1-13, 1963.

——Influence of climatic changes on vegetation of arid zone in India. *Ibid.* 4 : 64-73, 1965.

——Rajasthan desert can bloom with forage. *Indian Fmg.* 15 : 4-7, 1966.

Raizada, M. B. A botanical visit to Mt. Abu *Indian For.* 80: 207-215, 1954.

——Name changes in common Indian plants. *Ibid.* 84 : 467-538, 1958.

Raizada M. B. Name changes in common Indian Plants. *Indian For.* 85 : 473-509, 1959.

—— *Ibid.* 92 : 299-339, 1966.

—— *Ibid.* 94 : 432-462, 1968.

——R. C. Bharadwaja and S. K. Jain. Grasses of Upper Gangetic Plains. I. *Indian For. Rec.* (Bot.) n.s. 4(7) : 171-277, 1957.

—— and R. N. Chatterji. *Bergia polyantha* Sond. a new record for India. *Sci. & Cult.* 27 : 302-303, 1961.

——and S. K. Jain. First record of the genus *Dignathia* from India. *Indian For.* 87 : 426-428, 1961.

——and—— Grasses of Upper Gangetic Plains. II. *Indian For. Rec.* (Bot.) n.s. 5(3) : 151-221, 1964.

——and——Grasses of Upper Gangetic Plains. III. *Indian For.* 92 : 637-642, 1966.

—— and V. S. Sharma. New plant records for Upper Gangetic Plains from Ajmer-Merwara. *Ibid.* 88 : 356-359.

Ramachandran, K. R. Common grasses found round about Pilani. *Proc. Indian Sci. Cong.* II. 65-66, 1950.

Ramachandra Rao, Y. A list of more common plants of the desert areas of Sind, Baluchistan, Rajputana, Kathiawar & southwest Punjab, with local names. *ICAR Bull. Misc.* No. 43 : 1-45, Delhi. 1941.

Ramdeo, K. D. Plant life in relation to soil in Jodhpur & its neighbourhood. *Univ. Rajasthan Stud.* 31-38, 1955.

——Contribution to the flora of Udaipur, S. E. Rajasthan. *Mss.* 1963.

——Additions to the flora of Rajasthan. *Indian For.* 91: 123-125, 1965.

Ratnam, B. V. The vegetation of Lohargal. *Proc. Rajasthan Acad. Sci.* 2 : 26-36, 1951.

——and M. C. Joshi. An ecological study of vegetation near about a temporary pond in Pilani. *Ibid.* 3 : 45-59, 1952.

——and K. D. Ramdeo. An ecological note on sewage farm vegetation at Jodhpur. *Univ. Rajasthan Stud.* (Bot. Sect.) 3 : 1-8, 1957.

Rolia, S. R. and K. C. Kanodia. Studies on vegetation and flora of Jodhpur Division I. *Annals Arid Zone* 1 : 16-46, 2 : 35-60 (1963) (See also 2: 189), 1962.

——and——Studies on ecology & vegetation of interior parts of Barmer & Jaisalmer districts in Rajasthan. *Proc. Indian Sci. Cong.* III. 321-322, 1962.

Saenis, T. S. The physiological anatomy of the plants of Indian desert. *J. Indian bot. Soc.* 1 : 33-41, 65-83, 97-113, 183-205, 237-251; 2 : 1-19, 61-115, 157-173, 217-235, 1919-1921.

Sankhla, K. S. Enumeration of flowering plants of northwest Rajasthan. *Univ. Rajasthan Stud.* (Biol. Sc.) 1 : 43-56, 1951.

Santapau, H. Contribution to the bibliography of Indian botany. *J. Bombay nat. Hist. Soc.* 50 : 520-548, 51 ; 205-259, 1952-53.

——*History of Botanical Research in India, Burma and Ceylon* II. *Syst. Bot. of Angiosperms*. Bangalore. 1958.

——Floristic studies in India. *Mem. Indian bot. Soc.* 1 : 117-121, 1958.

Sarin, J. L. The salinity of Rajputana desert. *Bull. nation. Inst. Sci.* 1 : 83-88, 1952.

Sarma, C. B. S. R. Study of grasses and sedges of certain areas in Jhunjhunu Dist., Rajasthan. *Proc. Indian Sci. Cong.* III: 338, 1967.

Sarup, S. Plant ecology of northwest Rajasthan. *Proc. Bull. Des. Res. Jerusalem* No. 2 : 335-345, 1952.

——Plant ecology of Jodhpur & its neighbourhood. *Bull. nation. Inst. Sci.* 1 : 223-232, 1952.

——The biological spectrum of flora of Mt. Abu. *Univ. Rajasthan Stud.* 10-19, 1952.

——Water economy and plant life of semi-arid region of Jodhpur. *Proc. Indian Sci. Cong.* III. 162, 1954.

——*A list of some common plants of Jodhpur & its neighbourhood,* 1-25, Jaipur, 1954.

——On some problems in the immobilisation of the Indian desert. *Jaswant. Coll. Mag.* 26 : 1-2, 1955.

——A brief note on vegetation of Rajasthan. *Dungar Coll. Mag.* 18 : 1-8, 1957.

—— *A list of common plants of Bikaner & its neighbourhood.* 1-12. Jaipur. 1957.

——*A list of some common plants of Jaisalmer & its neighbourhood.* 1-16, Jaipur. 1958.

—— The halophytes of the Indian desert. *Dungar Coll. Mag.* 23 : 1, 1958.

——Progress of desert ecology in India during 1950-56. *Univ. Rajasthan Stud.* (Biol. Sc.) 3 : 55, 1958.

——Hydrophytes of Jodhpur. *Ibid.* 3 : 61-70, 1958.

——Hydrophytes of Indian desert. *Ibid.* 3 : 71-76, 1958.

——Hydrophytes of Bharatpur. *Proc. Indian Sci. Cong.* III. 410, 1960.

——Vegetation of Bharatpur (Rajasthan). *Ibid.* III. 322-323, 1962.

—— and M. M. Bhandari. The protection & preservation of trees in Indian desert & conception of Vanmahotsava. *Proc. Symp. Vanmahotsava.* 1, 1956.

——and——Plant ecology of the Indian desert in retrospect and prospect. *Univ. Rajasthan Stud.* (Bot.) 3 : 98-124, 1957.

——and G. S. Puri. The vegetation types of the Indian desert. *Ibid.* 4 : 57-85, 1960.

——and——Studies on vegetation of arid zones of India II. The distribution of some desert plants in various habitats in Rajasthan State. *Ibid.* 4 : 87-88, 1960.

——and S. K. Tandon. Vegetation of Bharatpur. *Proc. Indian Sci. Cong.* III : 322, 1962.

——and L. N. Vyas. Ecological studies on vegetation of Jodhpur Tahsil. *J. Indian bot. Soc.* 36 : 589-590, 1957.

——and——Ecological studies on vegetation of Jodhpur Tahsil. *Univ. Rajasthan Stud.* (Biol. Sc.) 3: 77-97, 1958.

Satyanarayan, Y. Indigenous species in stabilisation of sand dunes. *J. Soil & Water Cons.* 7 : 47-51, 1958.

——Tree-lands or grasslands in the Rajputana desert. *Indian For.* 84 : 549-553, 1958.

——Ecology of central Luni basin. *Annals Arid Zone* 2 : 82-97, 1963.

——Habitats and plant communities of Indian desert. *Proc. Symp. Probl. Indian Arid Zone.* Jodhpur, 1964.

——and Y. D. Gaur. Phytosociological variations in floristic composition of vegetation in arid zone. I. Monsoonal vegetation of the alluvial plains. *Annals Arid Zone* 6 :178-199, 1967.

——and S. K. Saxena. An account of weeds of Central Research Farm, Jodhpur, Rajasthan. *J. Bombay nat. Hist. Soc.* 63 : 344-353, 1966.

——, —— and Y. D. Gaur. *Aerua persica* Merr., a host of *Cistanche tubulosa* (Sch.) Wt. *Ibid.* 62: 602, 1966.

Sen, D. N. Ecology of Indian desert. *Proc. Indian Sci. Cong.* III. 418, 1965.

Sen, N. N. A note on eradication of Water-Hyacinth in the Ghana Bird Sanctuary, Bharatpur, Rajasthan. *Indian For.* 87 : 168, 1961.

Seth, S. K. Management of dry zone soils. *Ibid.* 85 : 75-109, 1959.

——and M. A. Waheedkhan. Bioclimate & plant introduction in dry zone. *Ibid.* 85 : 376-384, 1959.

Shah, S. A. Trees or grasslands in Rajputana desert. *Ibid.* 83 : 488-491, 1957.

Shankarnarayan, K. A., A. Cherian and Y. D. Gaur. Ecology of dune vegetation at Osian (Rajasthan). *J. Indian bot. Soc.* 44 : 37-50, 1965.

Shankarnarayan, K. A. and Y. Satyanarayan. Grazing resources of Rajasthan. I. Grassland types of the alluvial plains. *Indian For.* 90 : 436-441, 1964.

Sharma, B. M. Ecological studies of weeds & their role in immobilisation of the desert. *Proc. Indian Sci. Cong.* III. 301, 1959.

——Ecological studies of weeds of Jaswant College Compound, Jodhpur. *Proc. nation. Acad. Sci.* 31 B : 427-437, 1961.

——Studies on vegetation of arid zone of India VIII. Composition of some scrub communities of Churu, Rajasthan. *Ibid.* 32B : 157-168, 1962.

——Composition and structure of plant communities of Churu, Rajasthan. *Trop. Ecol.* 6 : 106-123, 1965.

Sharma, V. S. The flora of Ajmer—A list of trees, shrubs and woody climbers. *J. Bombay nat. Hist. Soc.* 55 : 129-141, 1958.

——*Emex spinosa* (L.) Camp. (Polygonaceae), a new record for India. *J. Bombay nat. Hist. Soc.* 58 : 836-838, 1961.

Sutaria, R. N. Flora of Mt. Abu. *J. Univ. Bombay* n. s. 9B: 64-68, 1941.

Tamhane, V. A. Soils of Rajputana & Sind deserts. *Bull. nation. Inst. Sci.* 1 : 254-259, 1952.

Tandon, S. K. *The vegetation of Ladnum (Jodhpur).* 17-26, Jaipur, 1958.

van Steenis, C. G. G. J. A new hypothesis on the origin of deserts. *Bull. Jard. Bot. Buitenzorg* Ser. 3.14 : 50-55, 1934.

Verma, D. M. A study of vegetation & soil properties in an enclosed area at Kailana (Jodhpur) *Trop. Ecol.* 5 : 52-59, 1964.

——Studies in flora of southeast Rajasthan. *Proc. Indian Sci. Cong.* III : 406-407, 1965.

——, B. M. Wadhwa and O. P. Misra. Some additions to the flora of Rajasthan. *Proc. nation. Acad. Sci.* 35B : 163-170, 1965.

Verma, S. K. Notes on certain exotics and non-indigenous species at Mt. Abu. *Indian For.* 91 : 831-844, 1965.

——Vegetation types of Jaipur. *Ibid.* 93 : 7-17, 1967.

Vyas, L. N. Plant ecology of Jodhpur Tahsil. *Univ. Rajasthan Stud.* 2 : 39-46, 1955.

——Vegetation of Jaisamand lake, Alwar. *Proc. Rajasthan Acad. Sci.* 9 : 45-47, 1962.

——On the grasses of Alwar. *Univ. Rajasthan Stud.* 6 : 23-30, 1962.

——Studies on phytogeographical affinities of flora of northeast Rajasthan. *Indian For.* 90 : 535-538, 1964.

——Notes on flora of Alwar, northeast Rajasthan. *Ibid.* 90 : 688-694, 1964.

——Study of hydrophytes & marsh plants of Alwar & environs, *J. Indian bot. Soc.* 43 : 17-30, 1964.

——Vegetation of Alwar & its relationship with the northeastern Rajasthan vegetation. *Ibid.* 43 : 322-333, 1964.

——Studies on grassland communities of Alwar. *Ibid.* 43 : 490-494, 1964.

——Phytosociological studies on vegetation of sandy plains of Alwar district, northeastern Rajasthan. *Trop. Ecol.* 5 : 60-66, 1964.

——Contribution to plant ecology of Aravalli hills. I. Studies in the forest types of Alwar, Rajasthan. *J. Indian bot. Soc.* 44 : 51-57, 1965.

——Vegetation of Parashuram hills & its neighbourhood. *Ibid.* 44 : 149-162, 1965.

——Vegetation of hills around Alwar, northeastern Rajasthan, Phytosociological studies. *Ibid.* 44 : 305-313, 1965.

——Cyperaceae from Alwar. *Indian For.* 92 : 581-582, 1966.

——and R. S. Gupta. Annotated list of medicinal plants of Alwar, Rajasthan. *Proc. Rajasthan Acad. Sci.* 9 : 49-55, 1962.

——and——Vegetation of Tijara & its neighbourhood. *Mss.* 1962.

——and——Observations on vegetation of some sandy areas in Alwar district, northeastern Rajasthan. *Annals Arid Zone* 4 : 84-92, 1965.

——and K. D. Ramdeo. Contribution to plant ecology of Aravalli Hills. III. Vegetation of Kumbalgarh. *Proc. nation. Acad. Sci.* 34 B : 353-360, 1964.

——and——Contribution to flora of Rajasthan from Udaipur. *Indian For.* 91 : 672-675, 1965.

Wadia, D. N. Deserts of Asia, their origin and growth in late pleistocene time (Address at Paleobot. Inst. Lucknow). 1955.

Waheedkhan, M. A. Climate of the dry zone. *Indian For.* 85 : 139-181, 1959.

White, G. E. *Science & the future of Arid lands.* Unesco, Paris, 1960.

Yadav, J. S. P. Soils of the dry zone. *Indian For.* 86 : 274-295, 1960.